

Claims

1. A method for electrically investigating a wall of a borehole in a geologic formation, the method comprising:
injecting (71) a current into the formation at a first position along the wall and returning the current at a second position along the wall, the formation current having a frequency below about 100 kHz;
measuring (72) a voltage in the formation between a third position and a fourth position along the wall, the third and fourth positions being located between the first and second positions; and
determining (73) an amplitude of a component of the voltage in phase with the current.
2. The method of claim 1 further comprising:
calculating (74) a formation resistivity from the current and the voltage component that is in phase with the current.
3. The method of claim 2, wherein calculating the formation resistivity includes applying scalar corrections (75) for current leakage and voltage inaccuracies.
4. The method of claim 1, wherein the current is injected through a source electrode and returned at a return electrode, each of the source and return electrodes being shielded by a conductive box held at the same electric potential as each electrode, the method further comprising measuring the current.
5. A method for analyzing borehole logging data, comprising:
determining an amplitude of a component of a recorded voltage signal in phase with a recorded current signal (81), the current signal recorded from a current injected into a formation at a first position along a borehole wall and returned at a second position along the wall, the voltage signal recorded

from a voltage measured between a third position along the wall and a fourth position along the wall, the third and fourth positions being between the first and second positions.

6. The method of claim 5 further including:
calculating a formation resistivity (82) using the recorded current signal and the component of the recorded voltage signal in phase with the recorded current signal.
7. The method of claim 6 wherein calculating the formation resistivity includes applying a scalar correction (83) for current leakage and voltage inaccuracies.
8. The method of claim 5 wherein the recorded current signal is a formation current that is calculated by subtracting a leakage current from the total current, the leakage current being calculated by using an experimentally determined leakage impedance.
9. A well-logging tool for making microelectrical measurements in a borehole, comprising:
a pad adapted to be placed into contact with a wall of the borehole;
a source electrode (2) located on the pad, the source electrode adapted to inject an electrical current into a formation;
a return electrode (3) located on the pad, the return electrode adapted to receive the electrical current injected by the source electrode;
an ammeter operatively connected to a circuit including the source and return electrodes;
at least one pair of voltage electrodes (4) located on the pad between the source and the return electrodes; and

- a phase sensitive detector (91) operatively coupled to the voltage electrodes and adapted to measure an amplitude of a component of a voltage across the voltage electrodes in phase with the electrical current.
10. The well-logging tool of claim 9, wherein the pad is comprised of a non-conductive material and further comprising:
a conductive backplate (92) disposed on a back face of the pad, and covering most of a region between the source and return electrodes.
 11. The well-logging tool of claim 9, wherein the phase sensitive detector is operatively coupled to the voltage electrodes and adapted to measure an amplitude of a component of a voltage across the voltage electrodes in phase with a calculated formation current.
 12. A method for electrically investigating a wall of a borehole in a geologic formation, the method comprising:
injecting a current into the formation at a first position along the wall and returning the current at a second position along the wall, the formation current having a frequency below about 100 kHz;
measuring a voltage in the formation between a third position and a fourth position along the wall, the third and fourth positions being located between the first and second positions;
calculating a formation current by subtracting a leakage current from the current;
and
determining an amplitude of a component of the voltage in phase with the formation current.
 13. The method of claim 12 further comprising:
calculating a formation resistivity from the formation current and the voltage component that is in phase with the formation current.

14. The method of claim 13, wherein calculating the formation resistivity includes applying a scalar correction for current leakage and voltage inaccuracies.
15. The method of claim 12, wherein the formation current is injected through a source electrode and returned at a return electrode, each of the source and return electrodes being shielded by a conductive box held at the same electric potential as each electrode.